

LCA of Power to Transport chains and the different roles of hydrogen

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I. Introduction

II. Goal and system description

III. Results

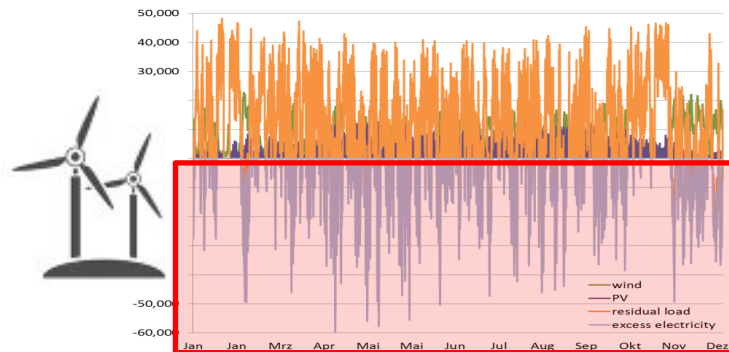
IV. Discussion and Conclusion

I. Introduction – Object of investigation

Power to Transport: Excess electricity used to supply vehicles.

Excess electricity

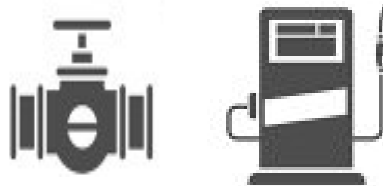
Renewable generation
higher than demand



Transport and distribution

Direct or with
geological storage

↓ Direct or energy conversion



Vehicle Operation



I. Introduction - The different roles of hydrogen

Guaranteed power supply requires storage. **Hydrogen** is a promising energy storage option.

Different roles of hydrogen:

FCEV: H_2 = Final energy for transport with additional option for geological storage.

BEV: H_2 = Intermediate energy carrier for geological storage.

SNG-ICEV: H_2 = Energy carrier used for production of synthetic natural gas (SNG).

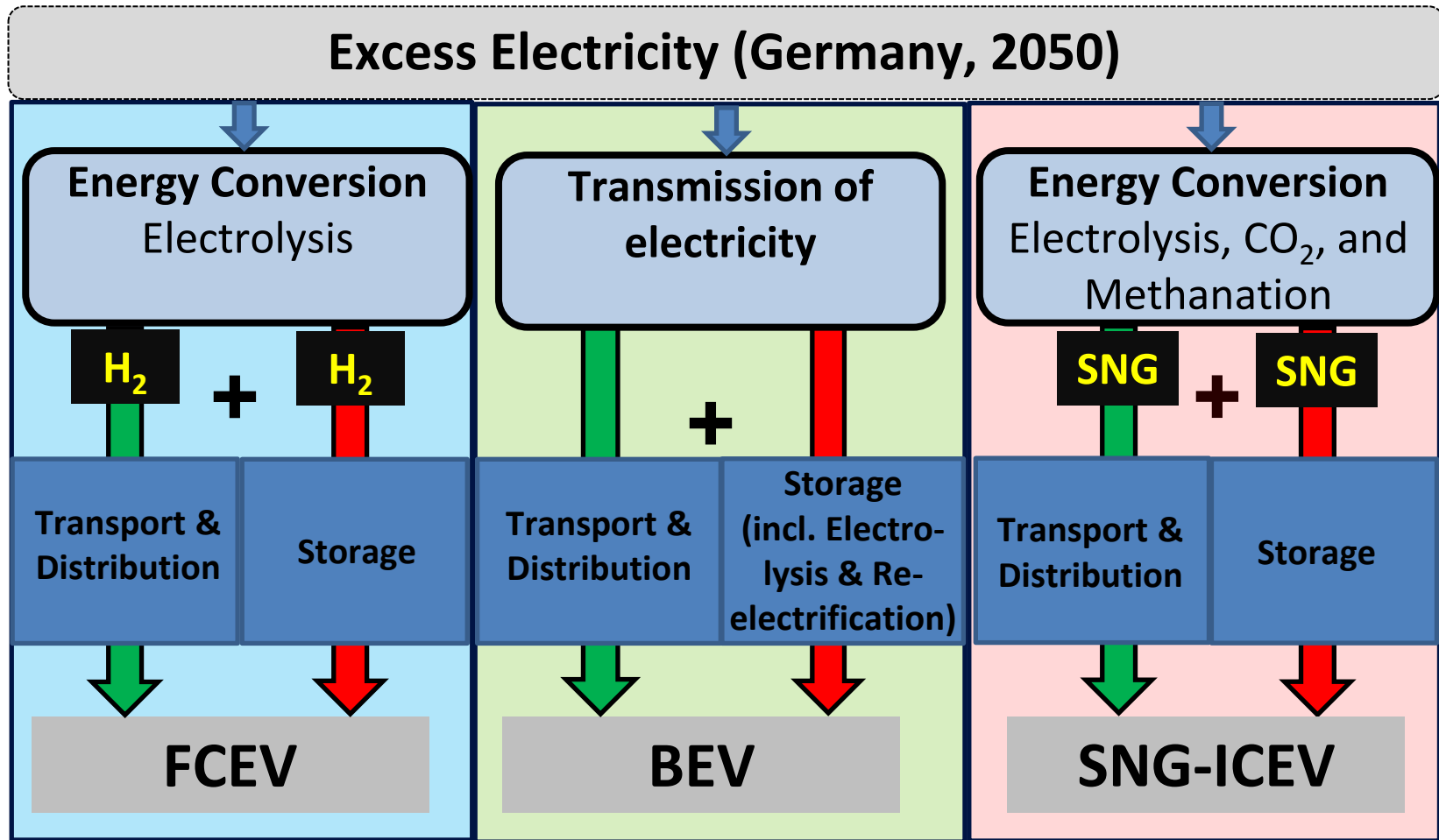
Goal

Life Cycle Assessment (LCA)

In-depth assessment of different Power to Transport chains based on the same excess electricity input, investigating deriving transport distances and comparison of environmental impacts.

II. Goal and system description

Systems investigated



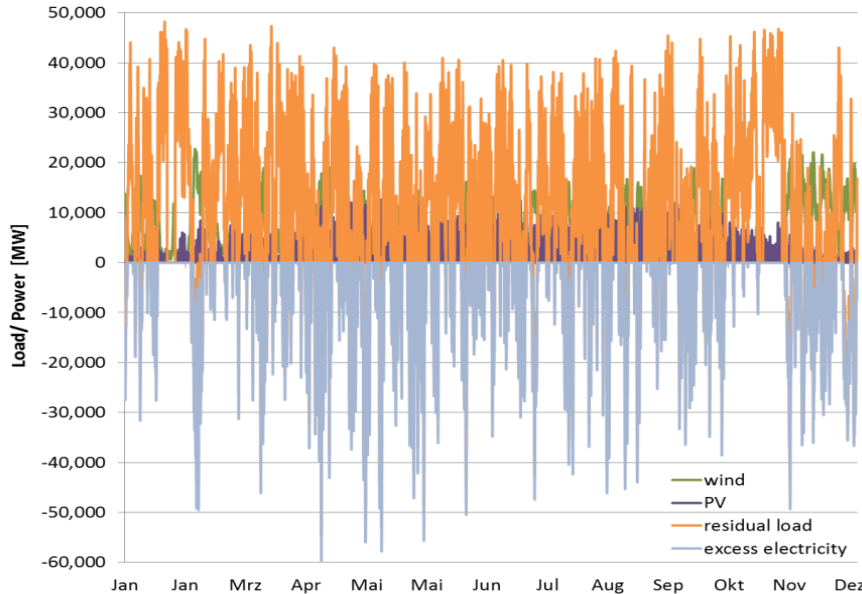
II. Goal and system description Framework

The LCA is based on:

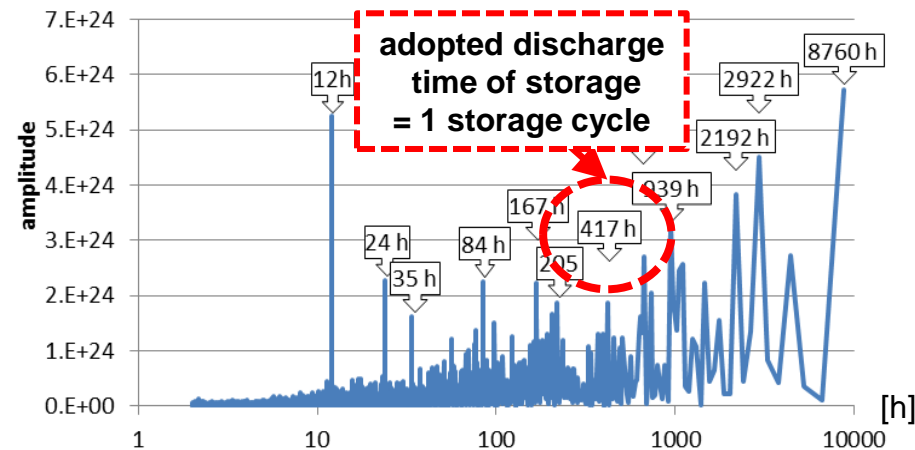
- excess electricity calculation including frequency analysis for storage sizing,
- future trends of system components,
- energy system scenario for 2050.

II. Goal and system description Framework

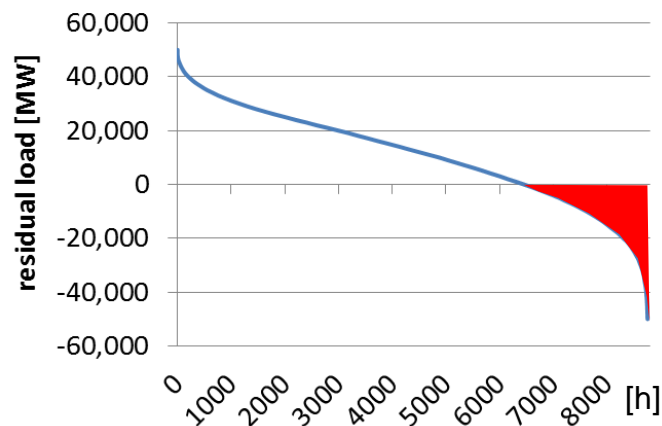
electricity demand/generation profile



frequency analysis of excess electricity



merit order residual load



2050 Scenario assumptions electricity sector
(source: "Energierferenzprognose", Prognos 2014)

Annual demand	excess electricity*	wind offshore capacity	PV capacity	wind onshore capacity	must run capacity **
487 TWh	98 TWh	21 GW	75 GW	64 GW	5 GW

- Excess of future demand; Additional options: REN curtailment or demand response e.g. industry or transport

** Minimum of controllable generation needed for systems services, assumption

II. Goals and system description

LCA description

Life Cycle Assessment methodology according to ISO standards 14040 and 14044, considering:

- 11 environmental impact categories (e.g. GWP) assessed based on the established ReCiPe characterisation model.

Comparison by functional unit:

Amount of excess electricity - common input for all 3 chains

Excess electricity cases according to ‘Energierferenzprognose’*

5 GW must-run (Base case):

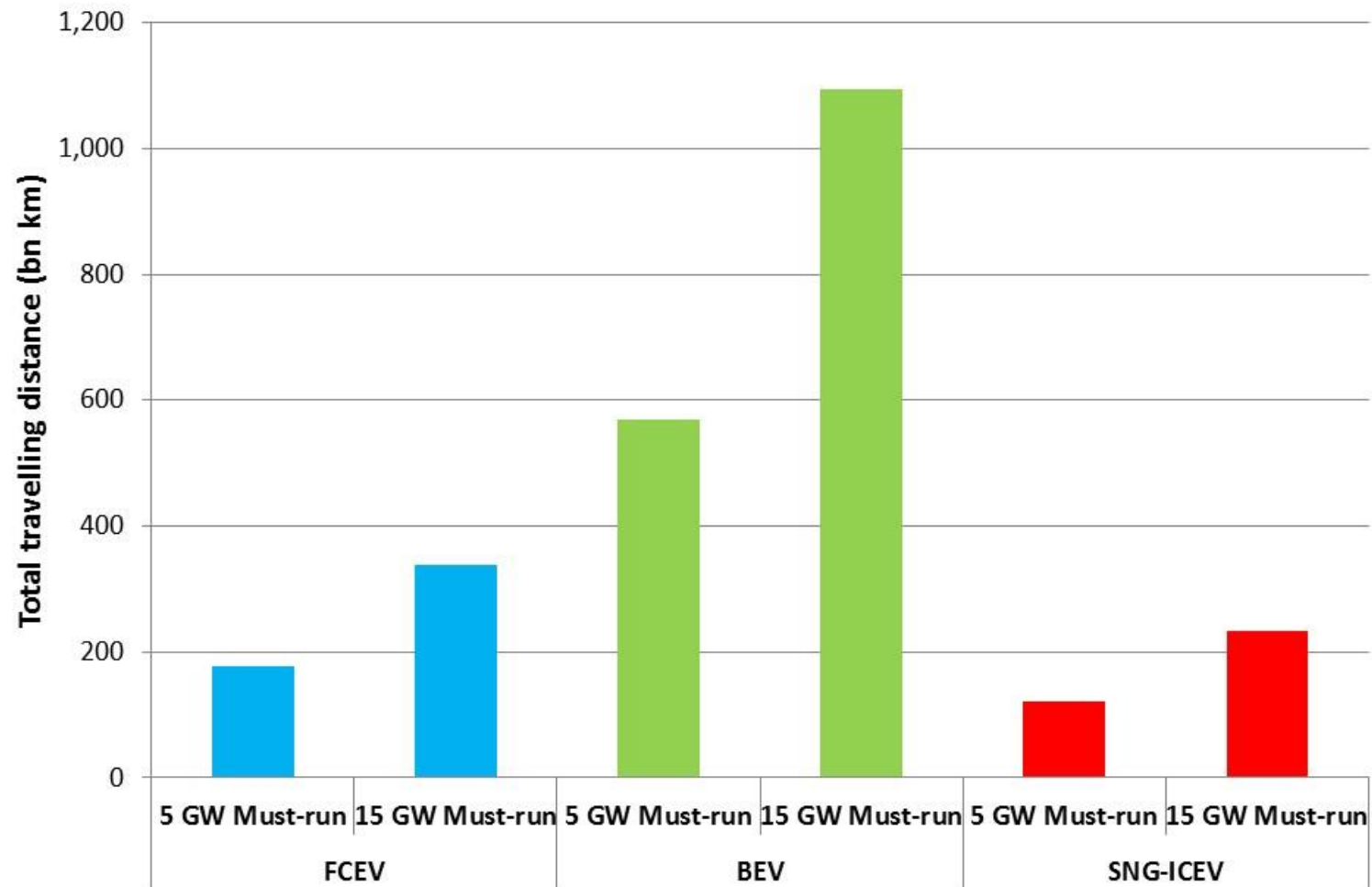
98 TWh excess electricity

15 GW must-run:

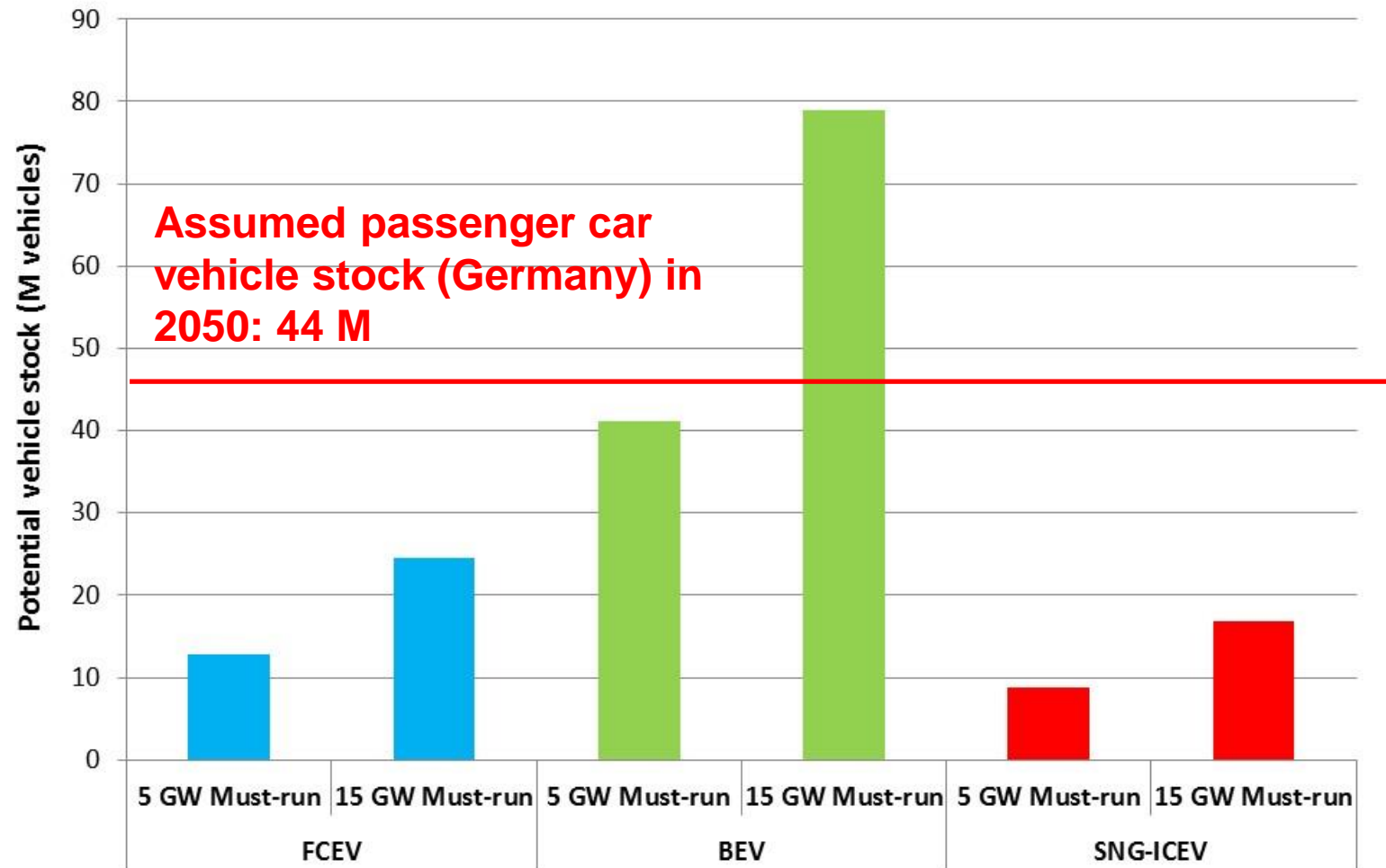
188 TWh excess electricity

* Energierferenzprognose (Prognos, 2014)

III. Results – Traveling distance

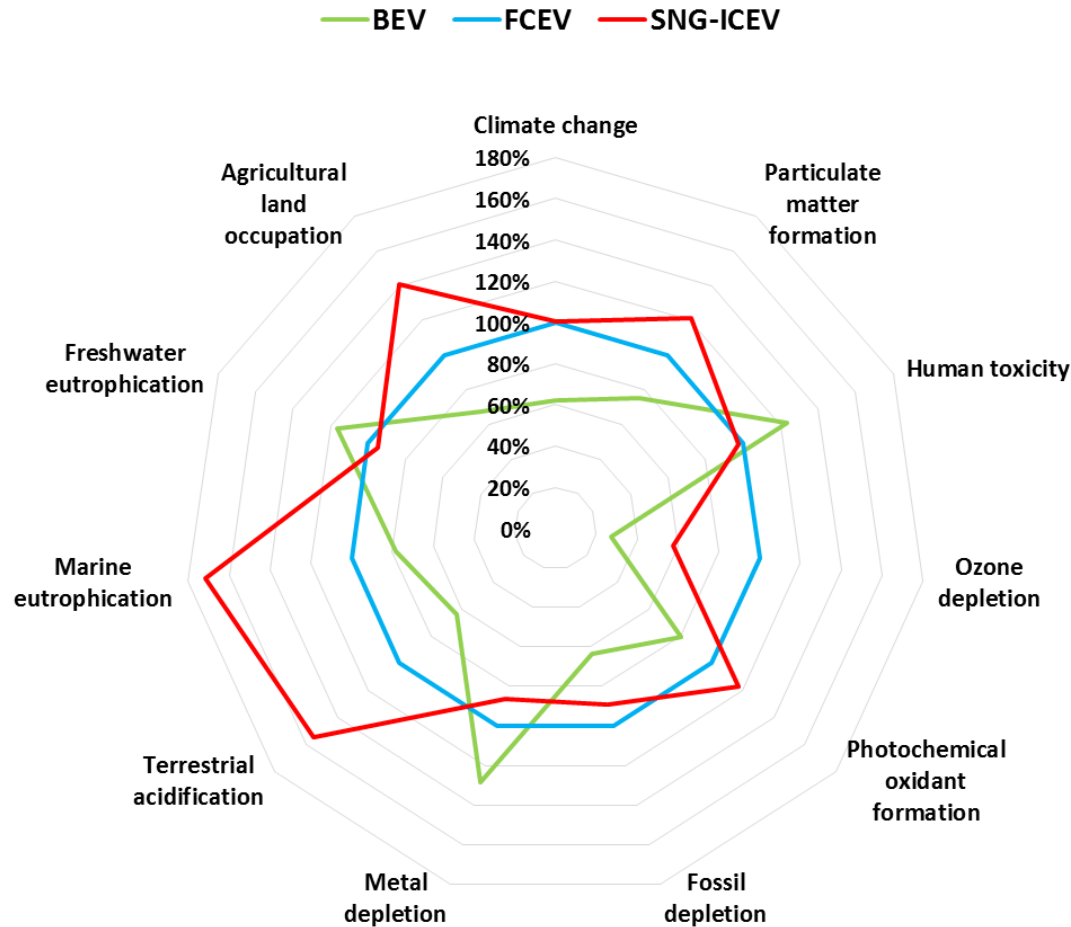


III. Results – Potential vehicle stock



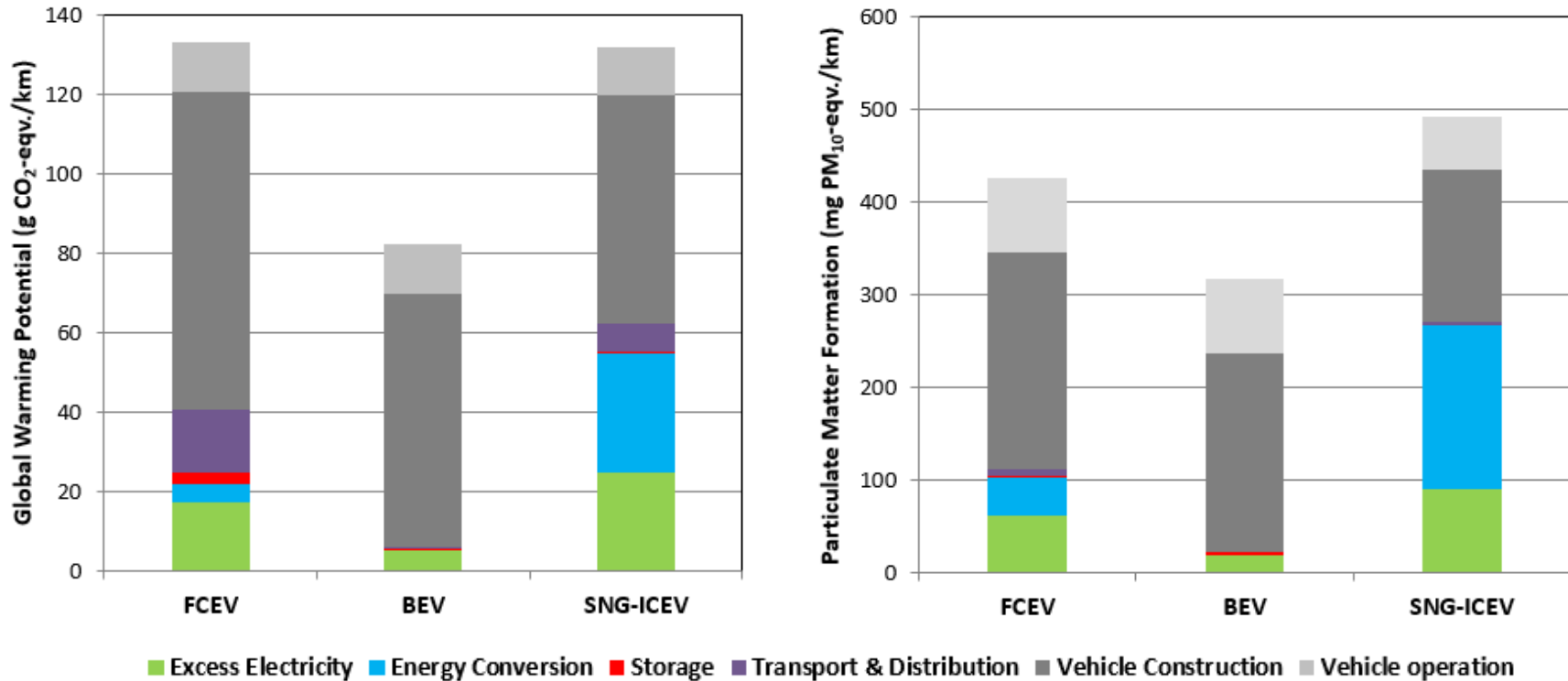
III. Results – Life Cycle Impact Assess- ment

**Environmental impacts per km of FCEV (=100%)
- 5 GW Must-run, 3 storage cycles -**



III. Results – Life Cycle Impact Assessment

Environmental Impacts – Share of life cycle stages - 5 GW Must-run, 3 storage cycles -



 **BEVs show lowest impacts in 8 of 11 categories**

Excess electricity enables high but divergent traveling distances with all chains.

Traveling distance affects the results.

Vehicle production of FCEVs and BEVs evokes highest contributions.

Especially the components batteries and fuel cells should be optimised to lower their impacts.

Storage reveals low contributions to environmental impacts.

Further research:

Assessment of accompanying economic effects of different Power to Transport chains, with focus on storage.

Improved integration of electrolysis operation with fluctuating wind electricity into LCA.

Increasing detailing of hydrogen transmission and distribution infrastructures and geological storages within LCA.

Thank you very much for your attention!

Contact

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